COMPARISON OF PERIAPICAL STATUS AND ENDODONTIC TREATMENT BETWEEN TYPE 2 DIABETIC AND NON DIABETIC INDIVIDUALS – *An In Vivo Study*

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CERTIFICATE

This is to certify that this dissertation titled "**COMPARISON OF PERIAPICAL STATUS AND ENDODONTIC TREATMENT BETWEEN TYPE 2 DIABETIC AND NON DIABETIC INDIVIDUALS –** ***An In Vivo Study***" is a bonafide record of work done by **Dr. Meena** under my guidance and to my satisfaction during her postgraduate study period between 2013 - 2016. This dissertation is submitted to THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY, in partial fulfillment for the award of the degree of Master of Dental Surgery in Conservative Dentistry and Endodontics, Branch IV. It has not been submitted (partial or full) for the award of any other degree or diploma.

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CONTENTS

INTRODUCTION

Diabetes mellitus (DM) is a group of complex multisystem metabolic disorder caused by a deficiency in insulin secretion. This could be due to pancreatic beta cell dysfunction (Type I) or insulin resistance in liver and muscle (Type II). Diabetes affects more than 9% of the adult population and has a dramatic impact on the health care system through high morbidity and mortality among affected individuals[1]

India leads the world with the largest number of diabetic subjects, earning the dubious distinction of being termed the "diabetes capital of the world"[1, 2]. The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. The most disturbing trend is the shift in age of onset of diabetes to a younger age in recent years[3].

DM alters many functions of the immune system and is associated with delayed healing and compromised immune response. This predisposes to chronic inflammation, progressive tissue breakdown, and diminished tissue repair capacity. Many chronic macrovascular and microvascular complications of diabetes have been reported in the literature with only a few reports about oral complications[4].

Several soft tissue abnormalities have been reported to be associated with diabetes mellitus in the oral cavity. These complications which are typically seen in uncontrolled diabetics include, periodontal diseases (periodontitis and gingivitis); salivary dysfunction leading to a reduction in salivary flow and changes in saliva composition, and taste dysfunction. Oral fungal and bacterial infections have also been reported in patients with diabetes. There are also reports of oral mucosal lesions in the form of stomatitis, geographic tongue, benign migratory glossitis, fissured tongue, traumatic ulcer, lichen planus, lichenoid reaction and angular chelitis. In addition, delayed mucosal wound healing, mucosal neuro-sensory disorders, dental carries and tooth loss has been reported in patients with diabetes.[4]

Diabetes has thus been regarded as a possible disease modifier in the oral cavity.

Of all the oral manifestations, the association between diabetes mellitus and periodontal diseases has been studied the most [5-8]. Many studies report that diabetes is a risk factor for gingivitis and periodontitis and it is more severe with poor glycaemic control[(8)]. The risk of developing periodontitis in patients with diabetes has been reported to be three times higher than the general population. It has been well established that periodontal diseases are more common in diabetics. Defects in immune status, altered bacterial flora, and microvascular disease are the postulated pathogenesis of diabetic periodontal disease[7].

The association between diabetes and endodontic disorders is still not clearly established. Diabetes has been suggested to influence the development, course, and response to the treatment of apical periodontitis (AP)[9]. Apical periodontitis (AP), an inflammatory process around the apex of the tooth is the primary sequelae to microbial infection of pulp space of the teeth and is a remarkably wide spread clinical problem linked with the same systemic disorders associated to periodontal disease[10]. The results of studies conducted so far are not conclusive, but suggest an association between DM and AP [11-13]. There is evidence from the literature associating DM with higher prevalence of AP, greater size of the periapical osteolytic lesions, greater likelihood of asymptomatic periapical infections, and delay / arrest of periapical repair. The prognosis for root filled teeth is worse in diabetics, showing a higher rate of root canal treatment failure with increased prevalence of persistent chronic apical periodontitis[14]. The results of some studies suggest that chronic periapical disease may contribute to diabetic metabolic dyscontrol[15]. Moreover it has been found that patients with diabetes have a reduced likelihood of success of endodontic treatment[12]. Further prospective in vivo epidemiological studies are needed to better understand the relationship between DM and endodontic diseases.

There are not many studies in the literature evaluating the association of type 2 diabetes mellitus with the prevalence of AP and root canal treatment. Most of the studies done till date, are cross- sectional epidemiological studies[16]. There is a lack of Indian data on this aspect. This is surprising, given the high prevalence of Diabetes Mellitus in India. Moreover, there is a lack of awareness of the oral manifestations in Diabetes amongst Diabetologists and other health care workers of the Medical Fraternity. Screening for oral diseases amongst diabetics is not a common practice.

Hence this in vivo study aimed to evaluate the prevalence of Apical Periodontitis (AP) in patients with type II Diabetes Mellitus, and also compare the periapical status and endodontic treatment between diabetics and non diabetics in an urban population from Coimbatore, India.

There are various methods to evaluate the peri apical status of an individual. These include Periapical radiographs, Subtraction radiography, Orthopantomograms (OPG), CT scans, Tuned aperture computed tomography (TACT), and Cone beam computed tomography (CBCT)[17]. Panoramic radiographs (OPG) offer the advantage of a broader coverage of facial bones and teeth, have a very low patient radiation dose, and are convenient for the patient[17]. OPG has been used as a screening tool in detecting apical periodontitis in numerous studies[18].

AIM AND OBJECTIVE

AIM:

- To evaluate the prevalence of Apical Periodontitis in patients with type II Diabetes Mellitus aged 40 to 65 years

- To compare the periapical status and endodontic treatment between diabetics and non diabetics aged between 40 to 65 years, in an urban population from Coimbatore, India

OBJECTIVES:

- *Primary outcome measures*
    - To study the periapical status in patients with type 2 Diabetes Mellitus and compare it with non diabetics, in an urban population.
    - To study the periapical status of endodontically treated teeth in patients with and without type 2 diabetes.

- *Secondary outcome measures*

  Effect of glycemic control on periapical status and endodontic treatment in the diabetic population.

REVIEW OF LITERATURE

Orstavik et al (1986)[19] was a pioneer in introducing a scoring system for registration of apical periodontitis in radiographs is presented. The system was termed the periapical index (PAI) and provided an ordinal scale of 5 scores ranging from 1 (healthy) to 5 (severe periodontitis with exacerbating features). Its validity was based on the use of reference radiographs of teeth with verified histological diagnoses. Results from studies involving 11 observers and 47 selected radiographs documented that the PAI system was reasonably accurate, reproducible and able to discriminate between sub-populations. It also allowed for results from different researchers to be compared. The system has thence been used for the analysis of periapical radiographs in epidemiological studies, in clinical trials and in retrospective analyses of treatment results in endodontics.

Rohlin et al (1991) [45] examined the Observer performance in the assessment of the periapical pathology from panoramic and periapical radiography. Five endodontists, five general practitioners and five oral radiologists were asked to assess the periapical status of 117 teeth. The observers assessed the panoramic and periapical radiographs of the teeth, which were evenly distributed throughout the jaws with a 50% probability that either an osteolytic or sclerotic lesion was present. When the oral radiologists acted as observers, the mean p value for periapical radiography was higher than for panoramic radiography *(P<O.OOI),* resulting in periapical radiography presenting a higher overall diagnostic accuracy than panoramic radiography for all observers *(P<O.OI).* There was, however, no difference between panoramic and periapical radiography when the two groups of endodontists and general practitioners acted as observers. The comparison of the three groups of observers showed no difference between their diagnostic accuracy when assessing panoramic radiographs. With

periapical radiography, the oral radiologists demonstrated a higher diagnostic accuracy than the endodontists *(P<0.05)*.

Molander et al (1993)[44] compared panoramic and intraoral radiographs from 400 consecutive patients for their ability to demonstrate periapical pathology and caries. Periapical osteolytic and sclerotic lesions as well as approximal caries were recorded independently by two observers. They concluded that panoramic and intraoral radiography perform equally well as diagnostic tools for the detection of periapical lesions, although the results are not identical. They also stated that panoramic radiograph had a very small radiation dose.

Sikri Vimal et al (1996)[20] analyzed the effect of quality of root filling and the coronal restoration on the radiographic periapical status of endodontically treated teeth. The results showed a strong association between treatment and the presence or absence of periapical inflammation. It also confirmed that good endodontic filling and good coronal restoration are the most effective. It was also observed that good endodontic filling with poor coronal restoration gave better peri – radicular response at follow up of 1 year, when compared to poor endodontic filling with good coronal restoration. The study clearly indicated that endodontic treatment of good quality offered better prognosis. However, with the placement of good quality coronal restoration, the results were more encouraging.

Kohsaka et al (1996)[40] investigated the periapical tissue histologically after putpal exposure in diabetic rats. It was found that diabetes increased the severity of periapical lesions in experimental rats. Inflammation in the apical periodontal ligament, root resorption, and alveolar bone resorption were greater in diabetic rats than in controls. Also, histometrically, vertical length, horizontal length, and area of periapical ligament in diabetic rats were larger ($p < 0.01$) than those in control rats. The histometrical study revealed that, in experimental rats, the lesion in the periapical area was significantly larger than in controls. Alveolar bone resorption and inflammation in the apical periodontal membrane in the diabetic group were observed to be more severe than those activities in the non diabetic group.

***Britto et al* (2003)**[18] investigated the prevalence of radiographic periradicular radiolucencies in endodontically treated and untreated teeth in patients with and without diabetes.. They found that individuals with type 2 diabetes who had endodontic treatments were more likely to have residual lesions after treatment. The authors concluded that type 2 diabetes are associated with an increased risk of periradicular tissues to odontogenic pathogens

***Fouad* (2003)**[21] reviewed the literature on the pathogenesis, progression, and healing of endodontic pathosis in diabetic patients. The natural history of endodontic infections and endodontic treatment outcome in diabetics was addressed in this review article. The results showed that diabetics with preoperative perireadicular lesions had a significantly lower chance of successful outcome at two years compared with nondiabetics. They also observed that *F. nucleatum*, *P. micros,* and *Streptococcus* spp. were the most prevalent of the microorganisms examined. *P. endodontalis* and *P. gingivalis* were more prevalent among diabetics.

Bender and Bender (2003)[37] evaluated the oral manifestations of diabetes mellitus, with particular attention to the dental pulp. In a study involving 252 diabetics with poor glycemic control, a high rate of asymptomatic tooth infection was found. Inflammatory reactions were greater in diabetic states, and the increased local inflammation caused an intensification of diabetes with a rise in blood glucose, placing the patient in an uncontrolled diabetic state. This often requires an increase in insulin dosage or therapeutic adjustment. Removal of the inflammatory state in the periodontium created a need for a lesser amount of insulin for glycemic control. Thus, it is essential to remove all infections including those of the dental pulp. When diabetes mellitus is under therapeutic control, periapical and other lesions healed as readily as in nondiabetics.

Segura-Egea et al (2004)[22] investigated the quality of root fillings and coronal restorations and their association with periapical status in an adult Spanish population. They concluded that the incidence of AP in root filled teeth was high. Adequate root fillings and coronal restorations were associated with a lower incidence of AP; an adequate root filling had a more substantial impact on the outcome of treatment than the quality of the coronal restoration.

Siqueira et al (2005)[23] did a cross sectional study to determine the prevalence of periradicular lesions in root-filled teeth from an urban adult Brazilian population. They investigated the quality of root canal fillings and coronal restorations and their association with the periradicular status of these teeth. Their results revealed a high prevalence of periradicular lesions in root-filled teeth, which was comparable to that reported in other methodologically compatible studies from diverse geographical locations. In addition, even though the coronal restoration had a significant impact on the periradicular health, the quality of the root canal filling was found to be the most critical factor in this regard.

***Segura-Egea et al* (2005)**[13] studied prevalence of Apical Periodontitis(AP) in patients with and without type 2 diabetes mellitus in a retrospective cohort study. The authors evaluated 38 subjects with diabetes and 32 control subjects and found that apical periodontitis was present in at least one tooth in 81.3% of diabetic patients and in 58% of the control subjects. They concluded that Type 2 diabetes mellitus is significantly associated with an increased prevalence of AP.

Iwama A et al (2006)[24]investigated the relationship between type 2 diabetes mellitus and anaerobic bacteria detected in infected root canals. They also performed a chemotaxis assay using polymorphonuclear leukocytes from type 2 diabetic rats to evaluate the status of the host defence system. The results showed that the rate of obligate anaerobic bacteria detected in the infected root canal of rats with type 2 diabetes mellitus was significantly higher than that for the normal rats. They also observed that the chemotactic response of the polymorphonuclear leukocytes from the diabetic rats was significantly lower than that of the control rats, and the number of leukocytes was lower in the diabetic group. These results suggested that the metabolic conditions produced by type 2 diabetes mellitus in rats might lower the general host resistance against bacterial infections.

Estrela et al (2008) [46] assessed the accuracy of imaging methods for detection of apical periodontitis (AP). Imaging records from a consecutive sample of 888 imaging exams of patients with endodontic infection (1508 teeth), including cone beam computed tomography (CBCT) and panoramic and periapical radiographs, were selected. Sensitivity, specificity, predictive values, and accuracy of periapical and panoramic radiographs were calculated. Prevalence of AP was significantly higher with

CBCT. Overall sensitivity was 0.55 and 0.28 for periapical and panoramic radiographs, respectively. The authors concluded that AP was correctly identified with conventional methods when showed advanced status. CBCT was proved to be accurate to identify AP.

Stuart Garber et al (2009) [38] studied the effect of hyperglycemia on pulpal healing in exposed rat pulps capped with mineral trioxide aggregate. The results showed that teeth with a complete dentin bridge exhibited no inflammation of the pulpal tissue, whereas teeth with an incomplete or no bridge showed variable degrees of inflammation. Furthermore, pulps in the diabetic rats were significantly more inflamed after the pulp-capping procedure (p_0.005) when compared with the nondiabetic rats. This study showed that Sprague-Dawley rats with diabetes mellitus did not respond to pulp capping procedures as well as normal rats. Hyperglycemia clearly inhibits macrophage function including chemotaxis, phagocytosis, and bacterial killing. The resulting inflammatory state produces an unfavorable environment for angiogenesis, cellular proliferation, and wound healing, functions critical for the healing of dental pulp. Additionally, chronic hyperglycemia results in protein glycation, thereby impeding transcapillary diffusion of nutrients and waste products with a resultant impairment of normal healing. Impaired wound healing can lead to chronic irritation of a dental pulp on exposure. This phenomenon should be kept in mind when patients with diabetes mellitus are treated with vital pulp therapy.

Tavares et al (2009)[16] did a cross-sectional study determined the prevalence of apical periodontitis in 1035 root canal–treated teeth from adult French patients and investigated the influence of the quality of canal fillings and coronal restorations on the periradicular status. Periapical radiographs were used for analyses, and teeth were classified as healthy or diseased according to the periapical index scoring system.

Overall, the prevalence of apical periodontitis in root canal–treated teeth was 33%. Only 19% of the teeth had endodontic treatments rated as adequate. The success rate (number of healthy teeth) for cases with adequate endodontic treatment was 91%, which was significantly higher when compared with teeth with inadequate treatment (61%). Teeth with adequate restorations had significantly decreased prevalence of apical periodontitis (29%) as compared with teeth with inadequate restorations (41%). The combination of adequate endodontic treatment and adequate restorations yielded the highest success rate (93.5%). The quality of the endodontic treatment was the most important factor for success, although the quality of the coronal restoration also influenced the treatment outcome.

Santos et al (2010)[17] radiographically evaluated the relationship between the quality parameters of root canal fillings (apical extension, homogeneity, and taper) and periapical status. The results showed that there was a relationship between high standard of quality of the root fillings and high proportion of periapical radiographic normality. Significant changes in periapical status after endodontic treatment occured in the first-year follow-up with high predictability. Homogeneity presented as the least sensitive parameter of quality compared with taper and apical extension, possibly as a result of the high prevalence of the ideal condition, which ranged from 89.3%–97%. An altered taper was the main radiographic parameter associated with periapical lesions after 4- to 7-year follow-up period. Moreover, preoperative periapical lesions and the altered taper condition increased the chance of maintenance or the development of periapical lesions during the follow-up period. This study did not demonstrate a relationship between groups of teeth or the occurrence of complicating factors during the endodontic treatment and postoperative periapical status.

Yingying Su et al (2010)[42] investigated whether vitamin D intake assisted in improving the outcome of endodontic treatment for diabetic patients. They concluded that adjuvant therapy of vitamin D in diabetics resulted in an increase in the successful outcome of endodontic treatment for those patients.

***Lopez-Lopez et al* (2011)**[12] investigated radiographically the prevalence of apical periodontitis (AP) and endodontic treatment in a sample of adult type II diabetic patients and control subjects. In this cross-sectional study, the radiographic records of 50 adult patients reporting a history of well-controlled type 2 diabetes mellitus (DM) (study group) and 50 age- and sex-matched subjects who reported no history of DM (control group) were examined. Periapical status of all teeth was assessed using the periapical index score. The results showed that in adult patients, type II DM is significantly associated with an increased prevalence of AP and endodontic treatment.

Maskari et al (2011)[9] studied oral manifestations and complications of diabetes mellitus. They observed that several soft tissue abnormalities are reported to be associated with diabetes mellitus in the oral cavity. It was identified that diabetics with poor glycemic control are more prone to recurrent bacterial infections. The authors proposed that diabetic oral complications need to be identified and included in the ultimate care of diabetes. They also noted that chronic oral complications in patients with diabetes adversely affected the blood glucose control. The need for regular follow up of patients with diabetes mellitus by dentists was emphazised, and the major role that dentists should play in recognizing the signs and symptoms of diabetes and their oral complications was highlighted.

Gündüz et al (2011)[33]did a cross sectional study to determine the prevalence of periapical lesions in root canal-treated teeth in a rural, male, adult population. They also investigated the influence of the quality of root canal fillings on prevalence of periapical lesions. The overall success rate of root canal treatment was 32.1%. The success rates of adequate root canal treatment were significantly higher than inadequate root canal treatment, regardless of the quality or presence of the coronal restoration ($P < .001$). In addition, the success rate of inadequate root canal treatment was also significantly affected by the quality of coronal restorations. The authors concluded that the quality of the root canal treatment was a key factor for prognosis with or without adequate coronal restoration.

***Marotta et al* (2012)**[11]evaluated the prevalence of apical periodontitis (AP) and endodontic treatment in type 2 diabetic individuals as compared with nondiabetics from an adult Brazilian population using Full-mouth radiographs from 30 type 2 diabetic and 60 age- and sex-matched nondiabetic individuals. They found that AP was significantly more present in teeth from diabetic individuals than in nondiabetic controls .They concluded that AP was significantly more prevalent in untreated teeth from type 2 diabetics. They proposed that diabetes may serve as a disease modifier of AP, suggesting that diabetic individual can be more prone to develop primary disease. Interestingly, the findings did not confirm that diabetes may influence the response to root canal treatment since treated teeth had no increased prevalence of AP when compared with controls.

Christine Peters et al (2012)[41] studied the various imaging techniques to detect periapical changes. According to the authors, clinical examination, radiographic images taken with intraoral and extraoral techniques, radiographic subtraction techniques, ultrasound, MRI, tuned aperture computed tomography (TACT), computed tomography (CT) and Cone beam computed tomography CBCT. They concluded that assessment of endodontic treatment efficacy using 3D imaging from small field-of-view CBCT units held promise. Though two-dimensional periapical radiographs had a low predictive value to distinguish between periapical disease and health, panoramic radiographs served as a good screening tool and provided overview images for teeth, TMJ, sinuses, nasal cavity, maxilla and mandible.

***Nayak et al* (2013)**[25] reviewed the evidence from the literature associating diabetes mellitus with higher prevalence of AP, greater size of the periapical osteolytic lesions, greater likelihood of asymptomatic periapical infections, and delay / arrest of periapical repair. According to the authors, the prognosis for root filled teeth is worse in diabetics, showing a higher rate of root canal treatment failure with increased prevalence of persistent chronic apical periodontitis.

***Chakravarthy* (2013)**[14] assessed the literature on DM and its implication on pulp and periapical diseases, and their treatment outcome. Their research showed an increased prevalence of periapical lesions in diabetics, with decreased success rate of endodontic treatment. A reciprocal relationship existed between glycaemic control and chronic periapical lesions

Kaya et al (2013)[30] investigated the oral health (with regard to the periapical status, quality of root fillings and coronal restorations) in an urban adult Turkish subpopulation using digital panoramic radiographs. The prevalence of apical periodontitis was 0.4% in root-filled teeth and 0.8% in teeth without root fillings. The presence of apical periodontitis was significantly correlated with inadequate coronal restorations and root canal fillings. They concluded that tooth type, quality and type of coronal restorations, and length and homogeneity of root fillings significantly affected the periapical status.

Jersa and Rita (2013)[34] assessed the prevalence of apical periodontitis and quality of root canal fillings in an adult Riga subpopulation. The technical quality of root fillings was evaluated in terms of length in relation to the root apex and lateral adaptation to the canal wall. The periapical status was assessed using the PAI index. There was a statistically significant relationship between quality of root canal fillings and apical periodontitis($p<0.0001$). In teeth with complete fillings only 15% were with apical periodontitis, but apical periodontitis were detected in 342 teeth (35%) with incomplete root fillings. The prevalence of apical periodontitis was also high in this selected group of patients (72%). The results of this study indicated a high prevalence of apical periodontitis and low quality of root fillings in a selected adult Riga population

Rafael Astolphi et al (2013)[36] evaluated the effect of periapical lesions (PLs) on insulin signaling and insulin sensitivity in rats. The rats with PLs showed higher plasmatic TNF-α, lower constant rate for glucose disappearance values, and reduced pp185 tyrosine phosphorylation status but no change in serine phosphorylation status in white adipose tissue after insulin stimulation. They concluded that periapical lesions can cause alterations to both insulin signaling and insulin sensitivity, probably because of elevation of plasmatic TNF-α. The results from this study emphasize the importance of the prevention of local inflammatory diseases, such as periapical lesions, with regard to the prevention of insulin resistance.

Lima et al (2013)[39] studied the effect of diabetes mellitus on the pulp and periapical tissue. They stated that endodontic treatment of diabetic patients with root canal infections is related to a decrease in success, and these patients may have increased flare-ups. They must have endodontic treatment based on careful assessments and effective antimicrobial regimens of the root canal. Root canal treatment in patients with diabetes mellitus should be performed using controlled strategies to prevent dissemination of microorganisms through the use of intracanal disinfectants and decontamination prior to crown-down instrumentation. It is also important that prior to dental treatment, glycaemic control has to be established or the procedure has to be subject to medical clearance. The relationship between poorly controlled diabetes and periapical lesions remains unclear. Molecular knowledge of periapical lesions, microorganisms and the immunoinflammatory response, could better guide efficient endodontic treatment and offer new therapeutic directions for diabetic patients.

***Abbas Mesgarani et al* (2014)**[26] evaluated the frequency of periradicular lesions in diabetic patients in Babol, North of Iran. The duration of the diagnosis of diabetes (> 48 months was called long term and < 48 months short term) was taken as the quality of control of their diabetes. This study threw light on the frequency of periradicular lesions and the duration / quality of control of diabetes. It was observed that the frequency of periradicular lesions in diabetic patients was higher in long-term diabetic patients than the short-term diabetic patients.

Ferreira et al (2014)[27]evaluated the influence of diabetes mellitus on the periapical tissues and the success of endodontic treatment in those patients. The results of the study were inconclusive regarding the increasing prevalence of apical periodontitis and diabetes mellitus. Regarding the evaluation of the success of endodontic treatment, it was found that the success rate amongst diabetic patients was lower, though it was not statistically significant. However the study was limited by the small sample size of only 32 patients. The authors also emphasized on the need for further studies to assess the prevalence of apical periodontitis and progression in patients with diabetes mellitus.

Hebling et al (2014)[28]studied the prevalence and frequency of apical periodontitis and root fillings in 450 institutionalized Brazilian elderly individuals. They observed a significant correlation between the presence of periapical pathology and inadequate root-filled teeth. Inadequate root-filled teeth were associated with an increased prevalence of apical periodontitis in these subjects. The authors opined that this fact may result in increased endodontic retreatment needs for this population.

Gundappa et al (2014)[29] did a cross-sectional study to evaluate clinico-radiographically the prevalence of Apical Periodontitis (AP) in non- treated & endodontically treated teeth in a general population. A total of 503 new patients, aged 25-50 years were included in the study. All participants underwent Orthopantomograph (OPG) followed by Intra Oral Periapical Radiograph (IOPAR) of the diseased teeth. Periapical status of diseased teeth was assessed, using Peri Apical Index (PAI) score. The results showed that the prevalence of apical periodontitis in India is more as compared to other populations across the world. More number of patients had untreated teeth with apical periodontitis. Apical Periodontitis was more commonly seen in older age group (41-50years) as compared to younger age group in both non- treated and treated groups.

Fabricio et al (2014)[31] investigated the relationship between root fillings and the presence of apical periodontitis. Among the teeth with apical periodontitis, 32.3% had adequate endodontic fillings and 51.6% had inadequate fillings. There was a significant correlation between the quality of endodontic fillings that were considered adequate and lower frequency of apical periodontitis in this population. There was a wide diversity of criteria for the analysis of the quality of root filled teeth and the periapical status.

Cintra et al (2014)[35] measured glycosylated haemoglobin (HbA1c) in diabetic rats as a means of investigating apical periodontitis and periodontal disease for their effects on both blood glucose concentrations and long-term glycaemic control. The inflammatory infiltrate and alveolar bone resorption were more severe in diabetic rats ($P < 0.05$). Diabetic rats exhibited higher levels of HbA1c independent of apical periodontitis or periodontal disease ($P < 0.05$). However, the presence of oral infections in diabetic rats was associated with increased blood glucose concentrations ($P < 0.05$). The authors concluded that oral infections affect glycaemic conditions in diabetic rats and increase HbA1c levels in normoglycaemic or diabetic rats.

Segura et al (2015)[32] reviewed the literature on the association between endodontic variables and systemic health (especially diabetes mellitus and smoking habits). According to the authors, the results of the studies conducted so far were not conclusive, but suggested an association between Diabetes Mellitus and apical periodontitis. Diabetes Mellitus was associated with a higher prevalence of apical periodontitis, greater size of periapical osteolytic lesions, greater likelihood of asymptomatic periapical infections and delay/arrest of periapical repair. The prognosis for root filled teeth was worse in diabetics, with a higher rate of root canal treatment failure with increased prevalence of persistent chronic apical periodontitis. On the other hand, chronic periapical disease may contribute to diabetic metabolic dyscontrol. Prospective epidemiological studies are needed to better understand the relationship between Diabetes Mellitus and periapical inflammation.

Sanchez et al(2015)[43] studied the association between the prevalence of apical periodontitis and the glycemic control of type 2 diabetic patients. In a cross – sectional study, they examined the radiographic records of 83 type 2 diabetic patients. Glycemic control was assessed by the mean glycated hemoglobin levels (HbA1C). Apical periodontitis was assessed using the Periapical Index score (PAI). Based on the HbA1C levels, diabetics were classified as well controlled (<6.5) or poorly controlled (>6.5). The results revealed a significantly higher prevalence of AP in type 2 diabetics with poor glycemic control (p 0.03). However, there was no significant association between glycemic control and root canal treatment, and endodontic failure. The authors concluded that there was a definite relationship between glycemic control and periapical inflammation in diabetic patients.

MATERIALS AND METHODS

Individuals seeking routine dental care and attending the department of oral medicine of Sri Ramakrishna Dental College, Coimbatore were included in the study. The study group was composed of 40 type 2 diabetic individuals (23 males, 17 females), with ages ranging from 40 years to 65 years (mean, 51±8 years). Controls were age and sex matched for diabetics so that there were 2 non diabetics for each diabetic individual. Ages for the 80 non diabetics (42 males, 38 females) ranged from 40 to 65 years (mean, 50±8 years).

The Hospital scientific committee and the Institution Ethics committee approved the study, and all the patients gave written informed consent.

Periapical and endodontic status were diagnosed on the basis of examination of digital panoramic radiographs of the jaws. Two trained radiographic technician using a digital orthopantomograph machine (Orthhophos XG5, Sirona) took the panoramic radiographs. All films were Konica exposed for 1.1 s with 50 kV and long cone (Figures 1,2 &3). All teeth, excluding third molars, were recorded. Patients with total number of teeth less than 14 were excluded. Grossly decayed teeth were considered as absent. Teeth were categorized as root filled teeth if they had been filled with a radiopaque material in the root canal(s). The following information was recorded on a structured form for each subject

1. The number of teeth present
2. The number and location of teeth without root fillings (untreated teeth) having identifiable periapical lesions
3. The number and location of root-filled teeth

4. The number and location of root filled teeth having identifiable periapical lesions.

The periapical status was assessed using the periapical index (PAI) score (Table 1). Each tooth was assigned to one of the PAI scores by using visual references for the five categories within the scale. A score greater than 2 (PAI ≥3) was considered to be a sign of periapical pathology.

Table 1: PAI SCORE

PAI Score	Description of Radiographic findings
1	Normal Periapical Structures
2	Small changes in Bone Structures
3	Change in Bone Structure with Mineral Loss
4	Periodontitis with well — defined radiolucent area
5	Severe periodontitis with exacerbating features

Four endodontists (2 post graduate students, 2 certified, experienced endodontists) served as the observers. The observers were shown a selection of reference radiographs of typical cases. They were instructed to find the reference radiograph where the periapical area most closely resembled the periapical area of the patient. The corresponding score was assigned to the observed root. (Figures 4 & 5) When in doubt, a higher score was assigned. For multirooted teeth, the highest of the scores given to the individual root was used. The observers scoring the OPG were blinded as to whether the individual was diabetic or non diabetic. This was done to eliminate a selection bias. Each set of scores for each tooth were averaged and rounded off to the nearest unit value to get a ***true mean score***. If the average was 1.5, 2.5, 3.5 or

4.5, it was rounded off to the unit value closest to the most experienced observer's score.

The total number of teeth with apical periodontitis between both the groups was compared and tabulated.

The radiographs were also examined for root canal treated teeth. Root canal treatment was ranked as adequate when all canals were obturated with no voids in the filling mass and the apical terminus of the filling was 0 to 2 mm short of the radiographic apex (Table 2). In multirooted teeth with similar periradicular status for all roots, the root with the worst treatment quality was assessed. Coronal restoration was ranked as adequate when it was a permanent restoration that appeared radiographically intact with no detectable signs of overhangs, open margins, or recurrent caries. The prevalence of apical periodontitis in root canal treated teeth was assessed using the PAI score. The scores between both the groups were compared and tabulated.

Table 2: ADEQUACY OF ROOT CANAL TREATMENT

Coronal restorations (filling and crown)	1 – Adequate (radiographically sealed)
	2 – Inadequate (signs of overhangs or with open margins)
Adaptation of root filling	1 – Adequate in the coronal ½ of the root filling + adequate in the apical ½ of the root filling
	2 - Adequate in the coronal ½ of the root

	filling + Inadequate in the apical ½ of the root filling
	3 - Inadequate in the coronal ½ of the root filling + adequate in the apical ½ of the root filling
	4 - Inadequate in the coronal ½ of the root filling + Inadequate in the apical ½ of the root filling
Length of root filling	1 - Root filling ending $\leq$ 3 mm from radiographic apex
	2 - Root filling ending $\geq$ 3 mm from radiographic apex
	3 - Pulpotomy, material seen only in the pulp chamber
	4 - Flush, root filling ending at the radiographic apex
	5 - Over-filling, root filling material seen in the periapical area

Table 3: SCORING FOR ROOT CANAL TREATED TEETH

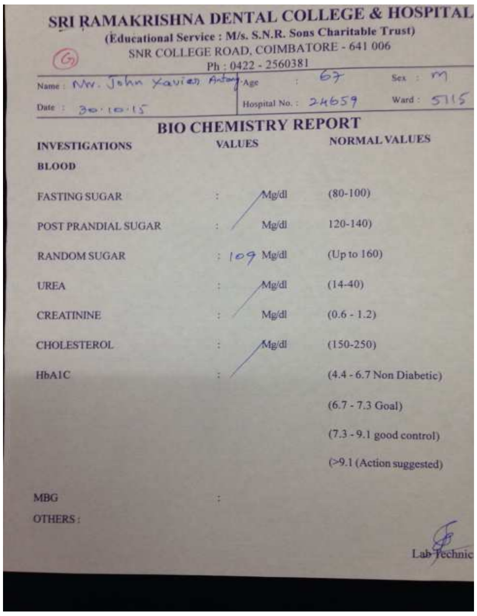
1. Adaptation of root filling to canal walls: adequate if no voids were present in the root filling; Score 1 = Adequate Scores 2, 3 and 4 = Inadequate
2. Length of root filling: adequate if ending ≤ 3 mmfrom, or flush with, the radiographic apex Score 1 and 4 = Adequate Score 2, 3 and 5 = Inadequate

In the diabetic group, the HbA1c levels were recorded as a proof of the glycemic control status, and an attempt was made to find out if the level of glycemic control had any effect on the prevalence of apical periodontitis.

Data were statistically analyzed to evaluate the significance in the differences between type 2 diabetic individuals and controls using the Wilcoxon signed rank and McNemar tests when the individual was the unit of analysis, whereas the chi-square test with Yates correction was used when tooth was the unit of analysis.

Figure 1: Glucometer

Figure 2: Random Blood Sugar



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G

Name : Mr. John Xavier Antony Age : 67 Sex : M
Date : 30.10.15 Hospital No. : 24659 Ward : 5115

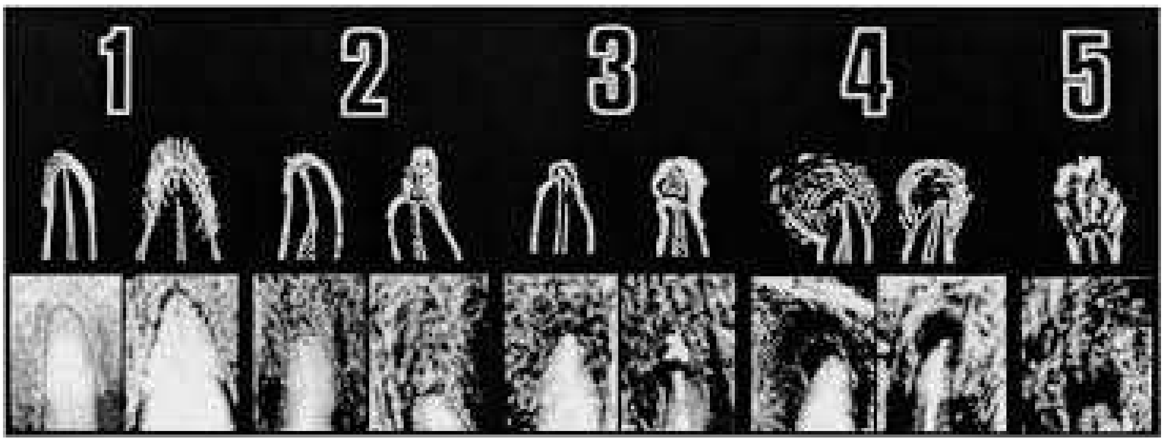
BIO CHEMISTRY REPORT

INVESTIGATIONS	VALUES	NORMAL VALUES
BLOOD		
FASTING SUGAR	: Mg/dl	(80-100)
POST PRANDIAL SUGAR	: Mg/dl	120-140)
RANDOM SUGAR	: 109 Mg/dl	(Up to 160)
UREA	: Mg/dl	(14-40)
CREATININE	: Mg/dl	(0.6 - 1.2)
CHOLESTEROL	: Mg/dl	(150-250)
HbA1C	:	(4.4 - 6.7 Non Diabetic)
		(6.7 - 7.3 Goal)
		(7.3 - 9.1 good control)
		(>9.1 (Action suggested)
MBG	:	
OTHERS :		

Lab Technic

Figure 3: Orthopantomogram

Figure 4: Periapical Index (PAI) scoring



PAI Score	Description of Radiographic findings
1	Normal Periapical Structures
2	Small changes in Bone Structures
3	Change in Bone Structure with Mineral Loss
4	Periodontitis with well — defined radiolucent area
5	Severe periodontitis with exacerbating features

Figure 5 A: Illustrated example of OPG with PAI scoring

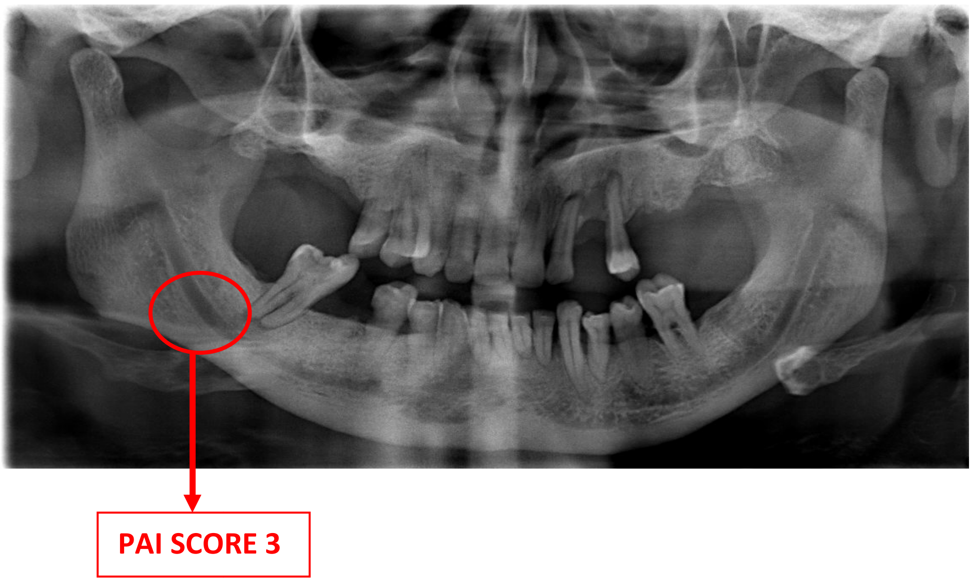


Figure 5 B: Illustrated example of OPG with Root canal Filling Score

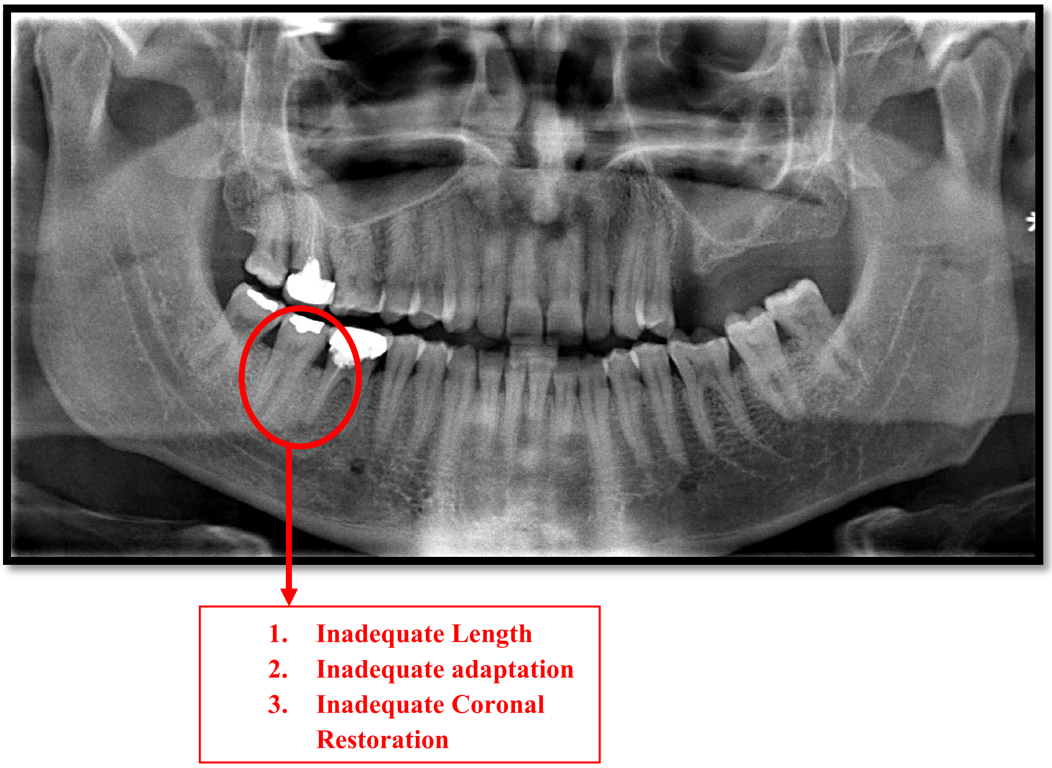
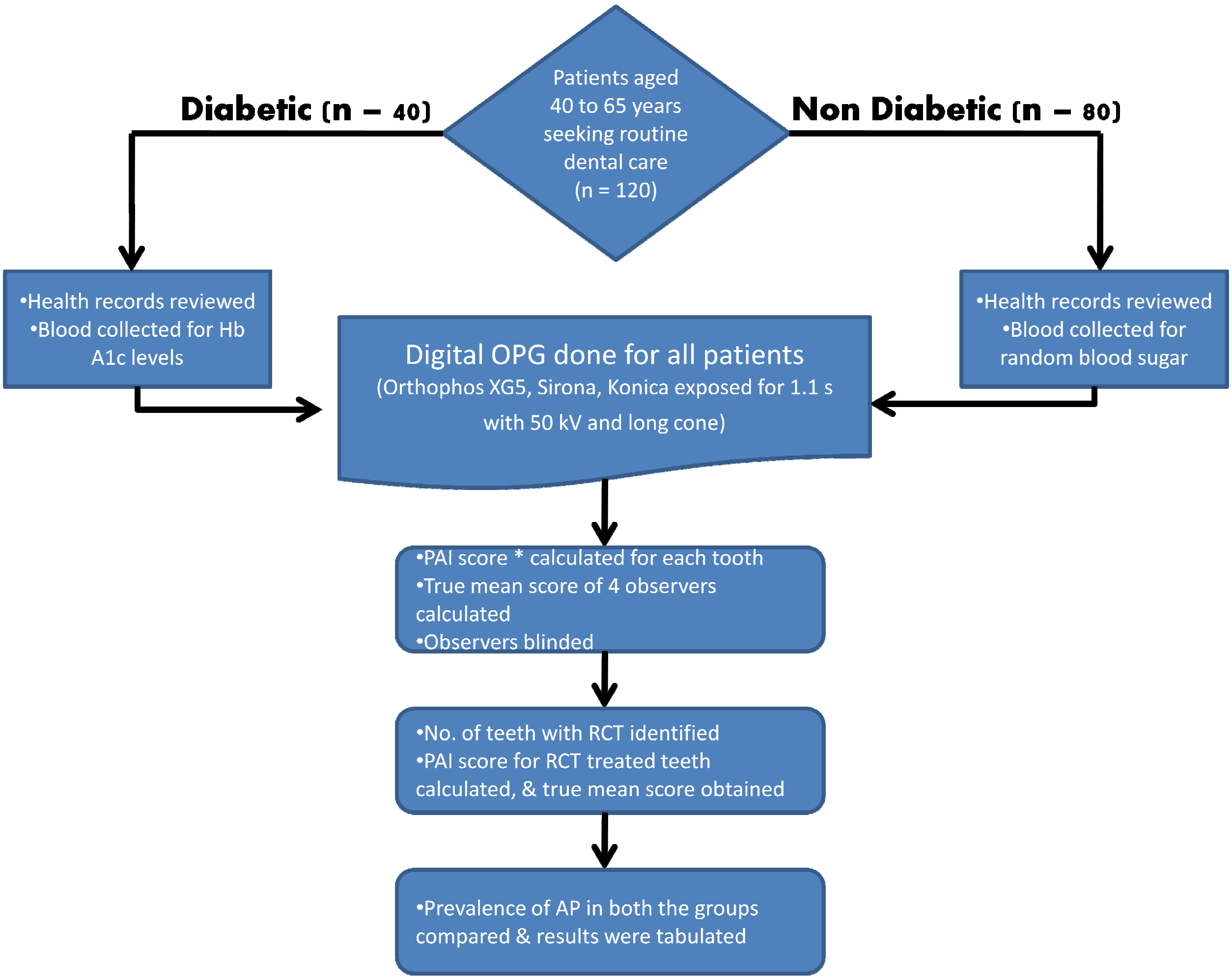


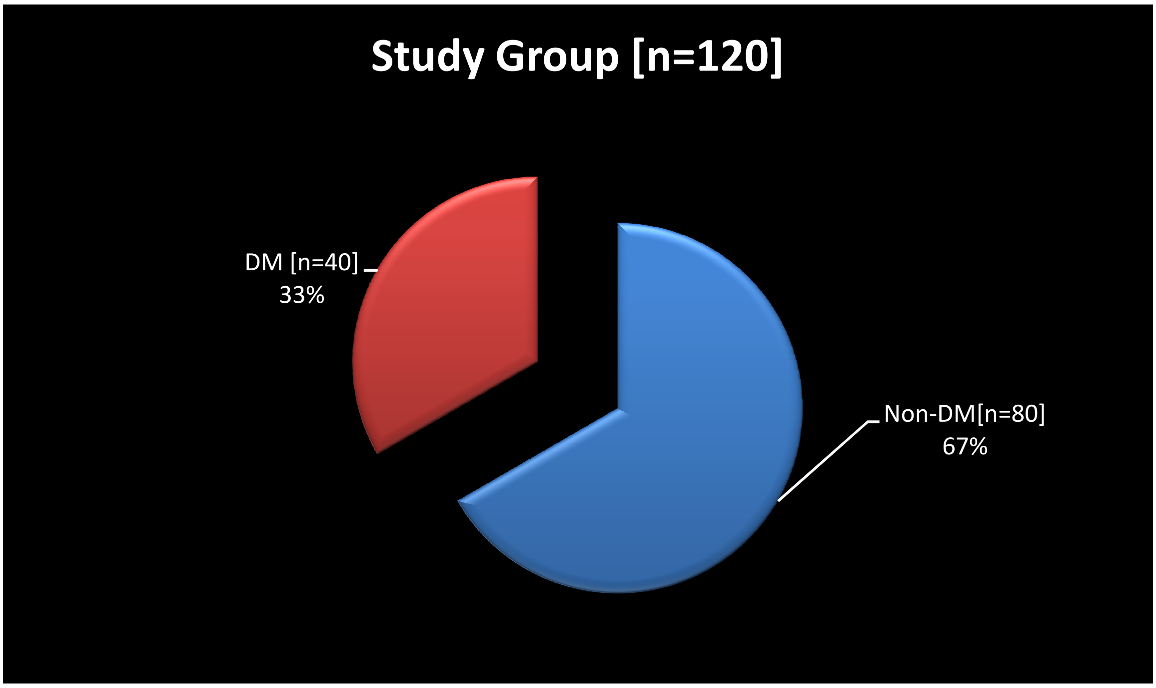
Figure 6 – schematic representation of the methodology of the study



RESULTS

STUDY GROUP

Figure 7: Study Group



The study group comprised of a total of 120 patients, of which 40 (33%) were diabetics and 80 (67%) were non diabetics. Each diabetic had 2 non diabetics who were age and sex matched (Figure 7)

BASELINE CHARACTERISTICS OF THE STUDY GROUP

Table 4: Age Distribution

Study Group				
AGE	**Non DM**	**DM**	**TOTAL**	**(%)**
40 - 50	55	19	74	62%
51 - 60	21	17	38	32%
> 60	4	4	8	7%
TOTAL	80	40	120	

Figure 8: Age Distribution

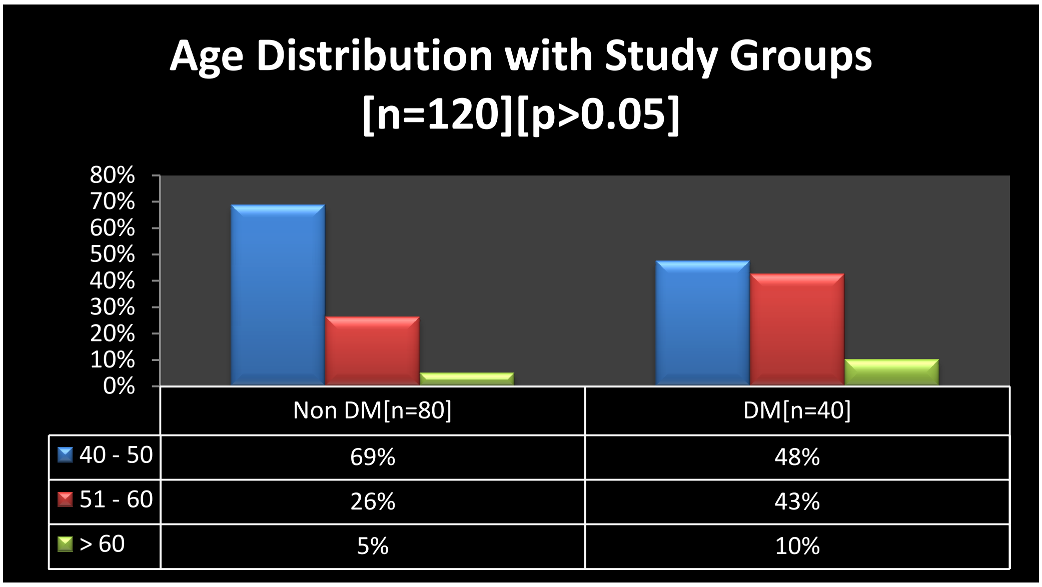
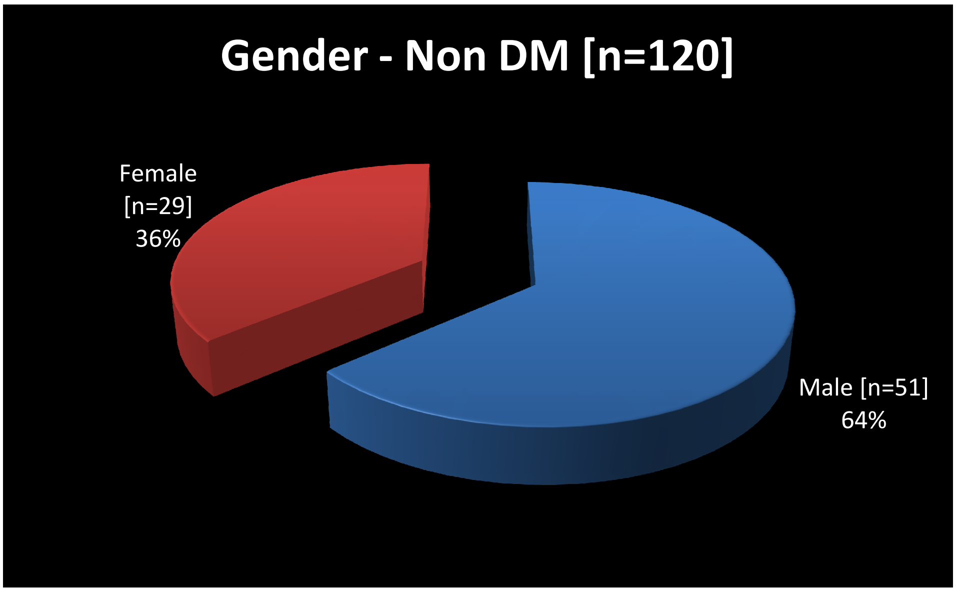
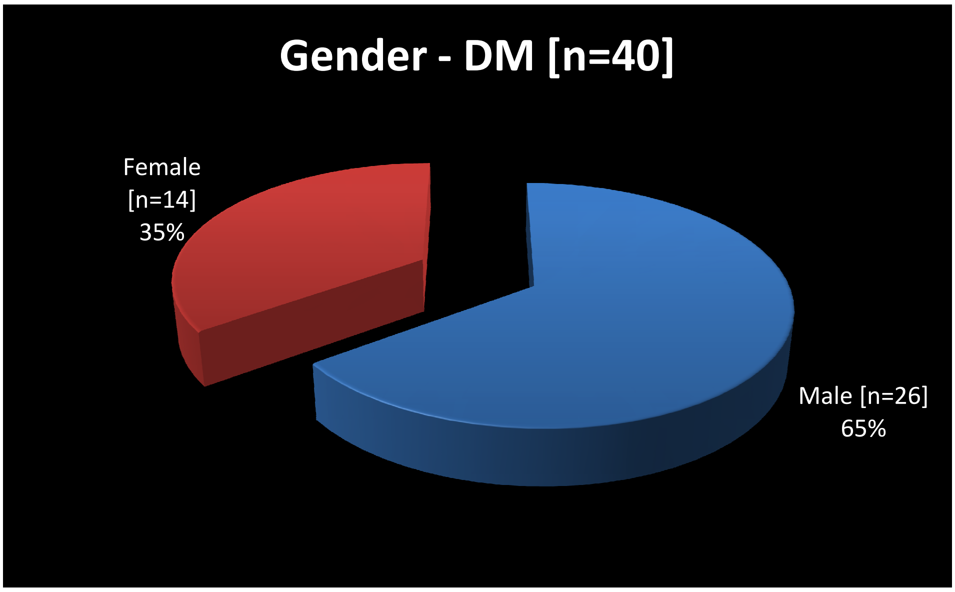


Table 4 and Figure 8 show the age distribution of the subjects in both the groups. The age distribution between diabetics and non diabetics was comparable. The mean age amongst the diabetics was 51 years, and amongst the non diabetics it was 48 years

Figure 9, 10: Gender Distribution



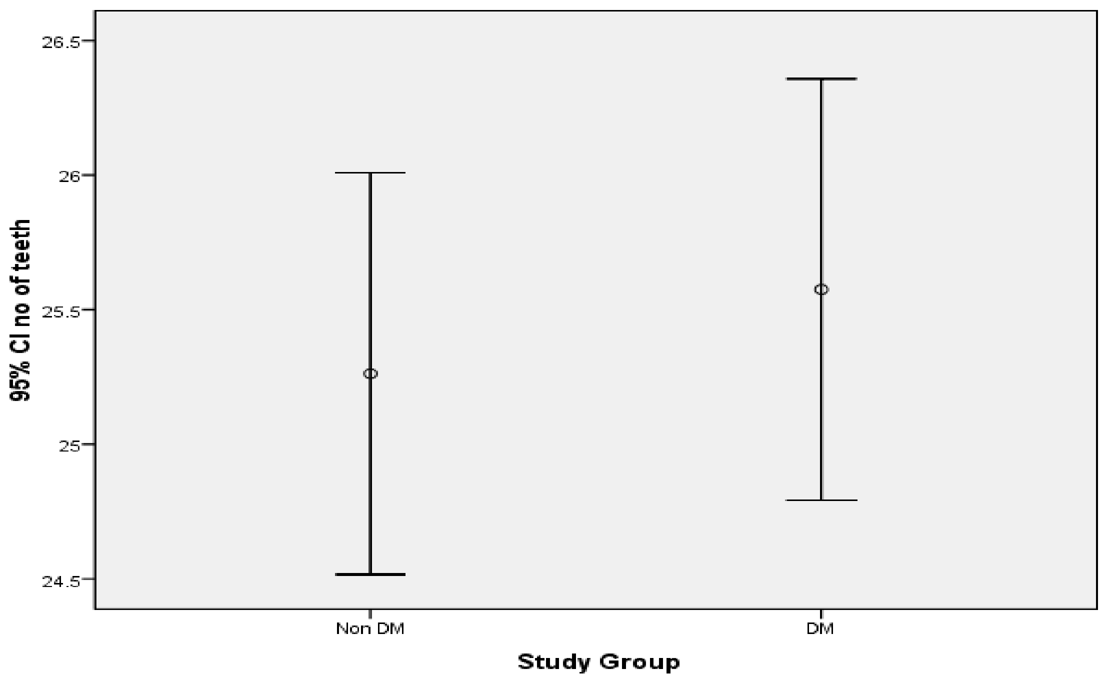


Figures 9 and 10 show the gender distribution amongst the non diabetic and diabetic groups. The percentage of males and females were comparable in both the groups.

Table 5: Mean number of teeth per person in both the groups

Mean Teeth per person							
Study Group	**Mean Teeth**	**SD**	**95% CI for Mean**		**Minimum**	**Maximum**	**Sig**
			Lower	**Upper**			
Non DM	25.3	3.4	24.5	26.0	12	28	
DM	25.6	2.4	24.8	26.4	19	28	>0.05
Total	25.4	3.1	24.8	25.9	12	28	

Figure 11: Mean number of teeth per person in both the groups

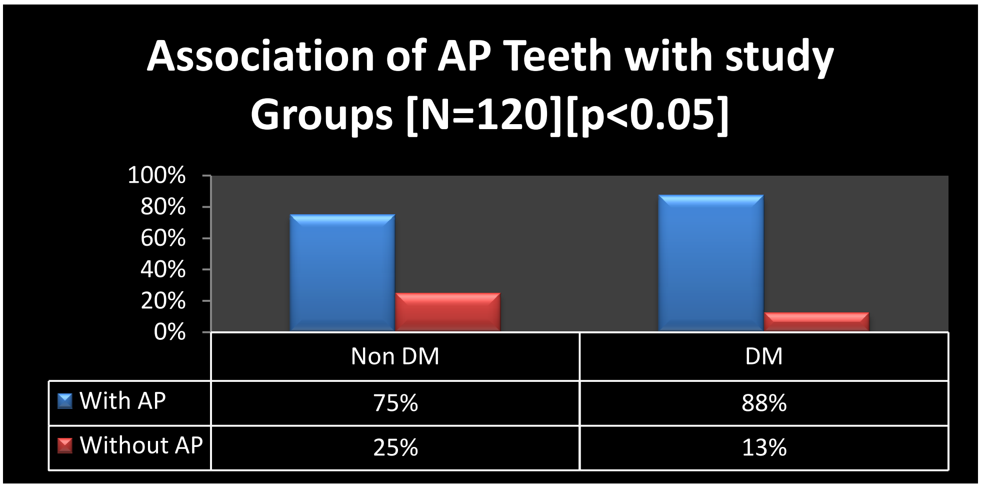


As seen in Table 5 and Figure 11, the mean number of teeth per person in the diabetic group was 25.6 ±2.4, and in the non diabetic group it was 25.3 ±3.4.

Table 6: Prevalence of Apical Periodontitis (AP) in diabetics (DM) and non diabetics (Non DM)

Prevalence of Teeth With AP				
	Non DM		**DM**	
Teeth	**No of Teeth**	**%**	**No of Teeth**	**%**
With AP	60	75%	35	88%
Without AP	20	25%	5	13%
Total	80		40	

Figure 12: Association of AP Teeth with study Groups



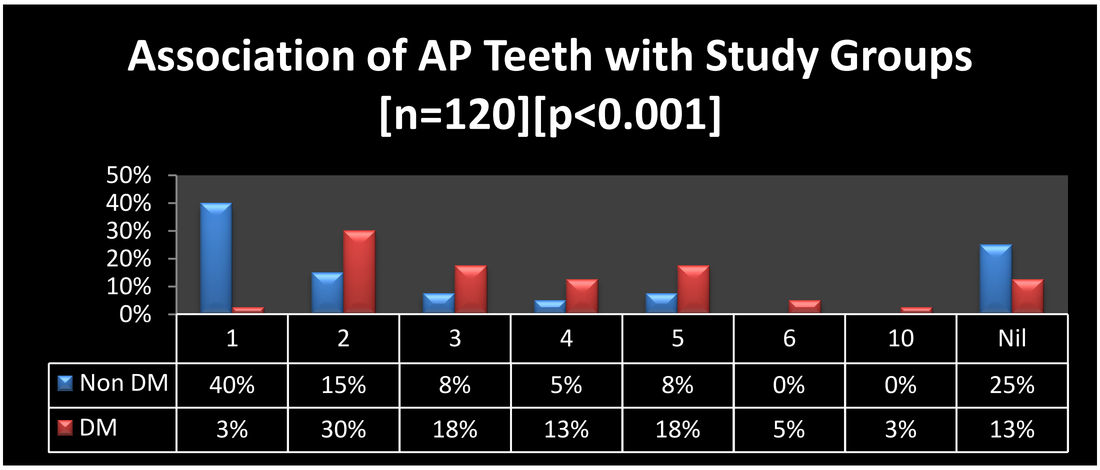
	OR	**95% CI**
DM with AP	5.000	[3.239 - 20.916]

Table 6 shows the comparison of the percentage of patients with apical periodontitis (AP) in diabetics and non diabetics, which is graphically represented in Figure 12. The prevalence of apical periodontitis was significantly more (88%) in the diabetics when compared with the non diabetics (75%). The Odds ratio (OR) was 5, which implies that diabetics are 5 times at a higher risk of having apical periodontitis, as compared to non diabetics.

Table 7: Number of teeth per person with Apical Periodontitis (AP) in both the groups

Association of AP Teeth with Study Groups				
No. of Teeth	**Study Group**		**TOTAL**	**(%)**
	Non DM	**DM**		
1	32	1	32	27%
2	12	12	25	21%
3	6	7	13	11%
4	4	5	9	8%
5	6	7	13	11%
6	0	2	2	2%
10	0	1	1	1%
Nil	20	5	25	21%
TOTAL	**80**	**40**	**120**	

Figure 13: Association of AP Teeth with Study Groups



As seen in Table 7 and Figure 13, it was interesting to note that majority of the non diabetics had only one tooth with apical periodontitis (AP), whereas the diabetics had more than one teeth with AP. In fact, there was one diabetic individual who had 10 teeth with AP. The p value was <0.001, which was statistically highly significant.

Table 8: Prevalence of Root canal Treatment (RCT) between both the groups

Prevalence of RCT				
RCT	**Non DM**		**DM**	
	No of Teeth	**%**	**No of Teeth**	**%**
Done	41	51%	22	55%
Not Done	39	49%	18	45%
Total	80		40	

Figure 14: Prevalence of RCT

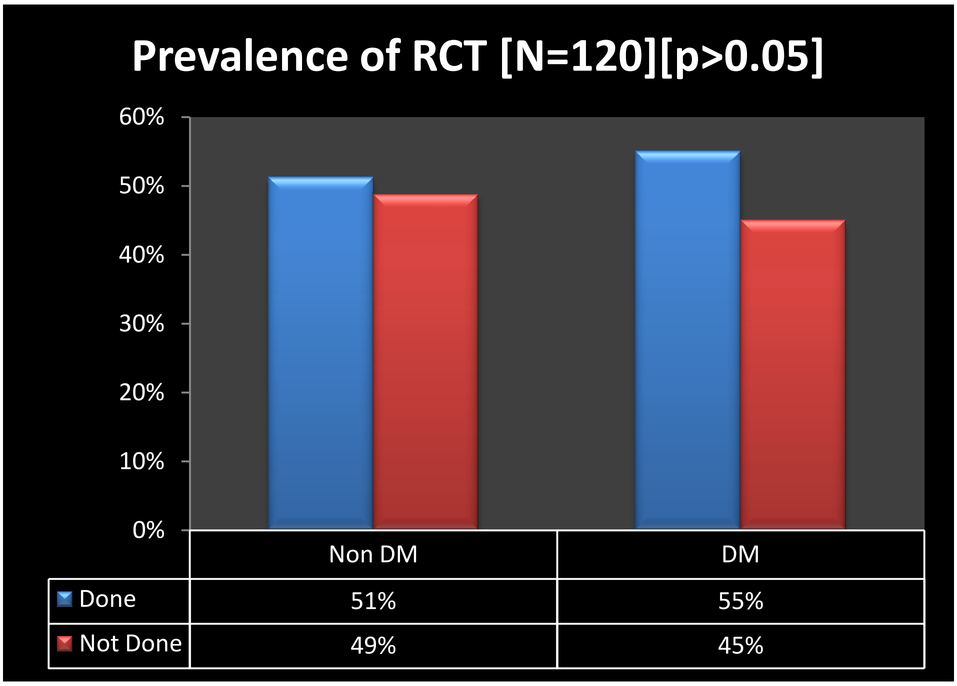


Table 8 and Figure 14 represent the prevalence of root canal treatment between both the groups. The total number of Root canal treated teeth was 63. 55% of the diabetics had root canal treated teeth, compared to 51% of non diabetics. Though non diabetics had a higher incidence of non treated teeth, this difference was minimal and not statistically significant. (p >0.05)

Table 9: Prevalence of AP in RCT treated teeth in diabetics and non diabetics

	Diabetic (n – 22)	Non diabetic (n – 41)	Total	p value
RCT treated teeth with AP	9 (41%)	12 (29%)	21	<0.05
RCT treated teeth without AP	13 (59%)	29(71%)	42	<0.05

Figure 15: AP in RCT treated teeth - Diabetics

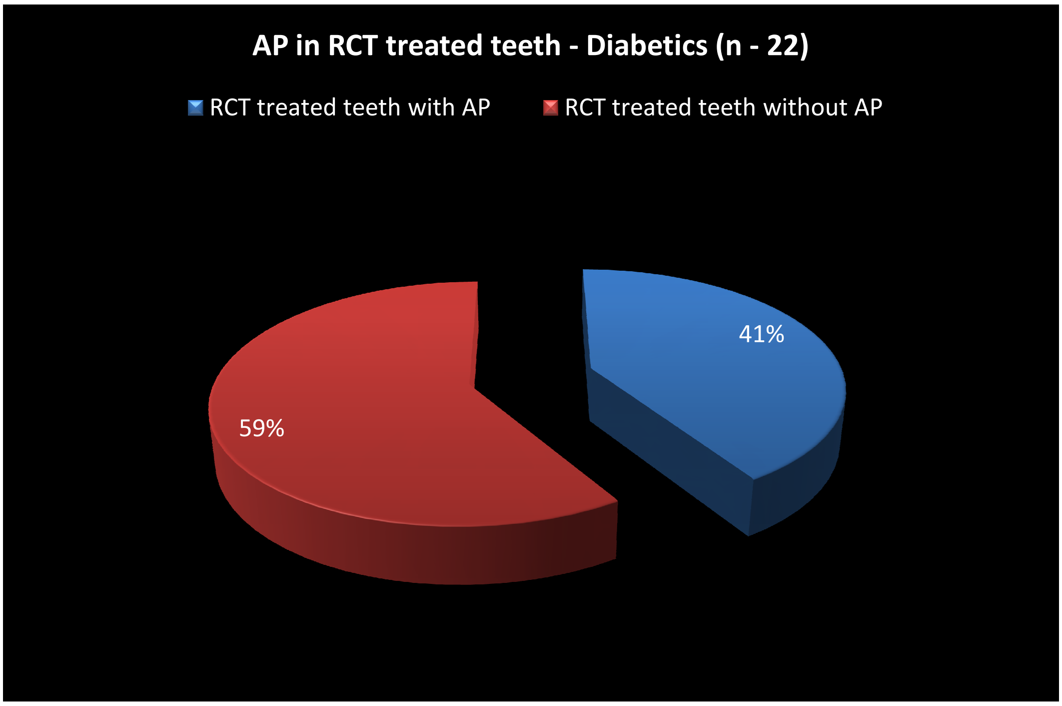


Figure 16: AP in RCT treated teeth - Non diabetic

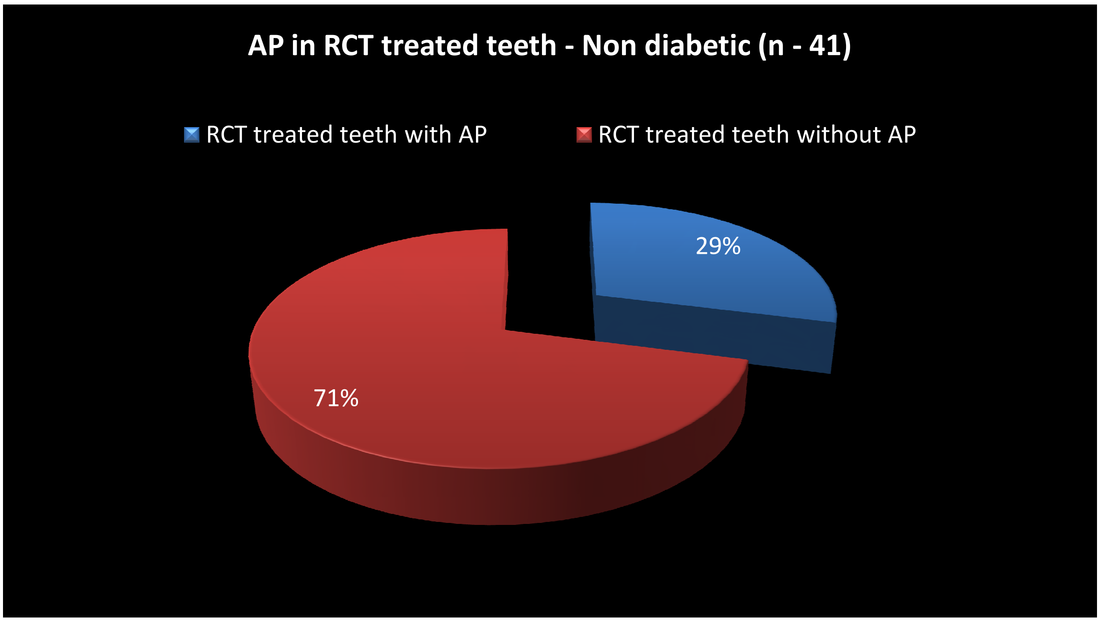


Table 9 shows the prevalence of apical periodontitis (AP) in root canal treated teeth amongst diabetics and non diabetics, which is graphically represented in Figure 15 and Figure 16 respectively. 41% of diabetic root canal treated teeth had apical periodontitis, whereas only 29% of non diabetic root canal treated teeth had AP. This difference was statistically significant with a p value of <0.05.

Table 10: Adequacy of root canal treatment in both the groups

Coronal restoration	**Non Diabetic**	**Diabetic**	
Adequate	29%	32%	>0.05
In adequate	71%	68%	
Length			>0.05
Adequate	73%	82%	
In adequate	27%	18%	
Adaptation			>0.05
Adequate	73%	82%	
In adequate	27%	18%	

In Table 10, the adequacy of root canal treatment between non diabetics and diabetics has been compared.

It was observed that the number of teeth with adequate coronal restoration, length of the filling and adaptation were similar between the diabetics and non diabetics, with a p value >0.05. Coronal restoration was inadequate in majority of the cases, while length and adaptation seemed adequate in most.

Table 11: Prevalence of AP in teeth with adequate root canal treatment (RCT) and coronal restoration (CR)

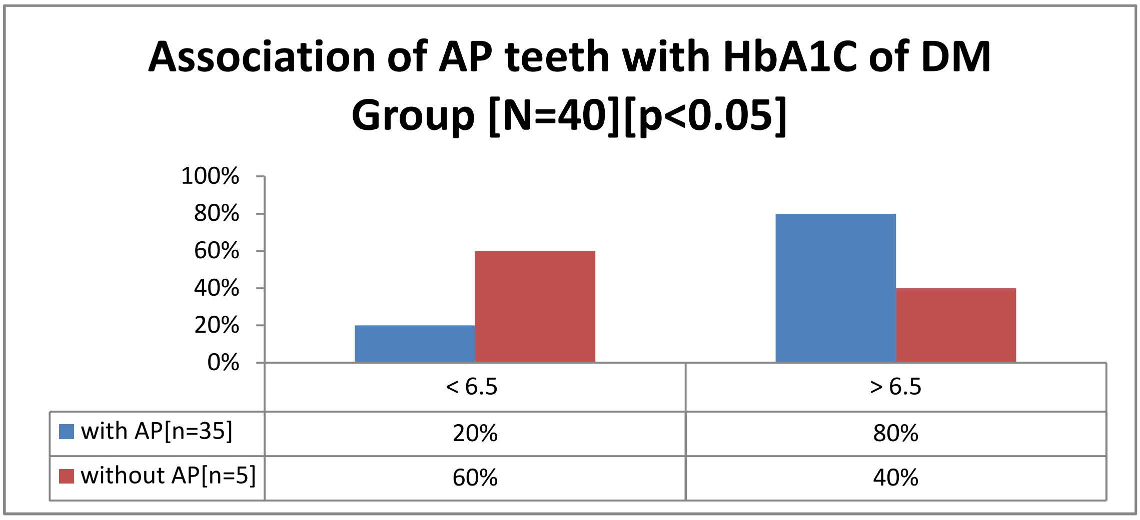
	Diabetic (n – 22)	Non diabetic (n – 41)	p value
No. of teeth with adequate RCT	17	32	>0.05
Adequate RCT with AP	6 (35%)	11 (34%)	
Adequate RCT without AP	11(65%)	21 (66%)	
No. of teeth with both adequate RCT and CR	6	11	>0.05
Adequate RCT & CR with AP	1 (17%)	2 (18%)	
Adequate RCT & CR without AP	5 (83%)	9 (82%)	

The number of teeth with adequate endodontic treatment in the diabetes group corresponded to 77% of the treated teeth, 35% of which displayed AP lesions (Table 11). In the control group, teeth with adequate endodontic treatment corresponded to 78% of the treated teeth, 34% of which had AP. This difference was not significant either (P > .05). As for teeth with both adequate endodontic treatment and adequate coronal restoration, 17% of those from diabetics and 18% from nondiabetics were associated with AP, a difference that was not significant either (P > .05).

Table 12: Correlation between HbA1c levels and prevalence of Apical Periodontitis (AP)

Association of AP teeth with HbA1c of DM Group				
HbA1C	**With AP**		**With Out AP**	
	No of Teeth	**%**	**No of Teeth**	**%**
< 6.5	7	20%	3	60%
> 6.5	28	80%	2	40%
Total	35		5	

Figure 17: Association of AP teeth with HbA1C of DM Group



	OR	**95% CI**
HbA1c (>6.5) with AP	6.000	[0.835 - 43.094]

As seen in Table 12 and Figure 17, 80% of diabetics with HbA1c levels >6.5(Poor glycemic control) had apical periodontitis (AP), whereas only 20% of diabetics with HbA1c <6.5(good glycemic control) had AP. The odds ratio was 6, which implies that diabetics with poor glycemic control (HbA1C >6.5) are at 6 times higher risk of acquiring AP compared to those with good glycemic control (HbA1C <6.5).

DISCUSSION

Endodontic infection and periodontal disease are very common conditions worldwide. Results from numerous studies have suggested links between periodontal disease and diabetes, but endodontic disease has not been studied extensively in this regard. The possible connection between chronic oral inflammatory conditions such as chronic apical periodontitis and systemic health is one of the most interesting areas currently being studied by the medical and dental scientific community. As there are so far very few studies in the literature reporting on diabetes as a disease modifier in endodontics, this cross-sectional study was conducted to investigate the prevalence of AP and endodontic treatment in type 2 diabetic individuals.

A cross-sectional design was used to include a large number of individuals. The subjects included in this study were adult patients attending dental service of the Dental College for the first time. The recruitment of subjects was the same as those used by other authors (***Kirkevang et al. 2000***[47]***, Britto et al.2003***[18]***, Fouad & Burleson 2003***[21]).

Both the study and the control groups consisted of more men than women; however, epidemiological studies have reported that sex had no effect on the presence of AP or the frequency of endodontic treatment (***Ørstavik et al. 1986***[19]***, Jime´nez-Pinzo´n et al. 2004***[48]). There was no significant difference in age between both groups. Both the groups were age and sex matched. Matching individuals by sex and age was performed with the purpose of reducing the interference of these variables on the final outcome.

In an attempt to circumvent possible biases, all the individuals participating in the study were attending the Dental college for the first time and basically pertained to the same socioeconomic status.

Orthopantomogram (OPG) was used to evaluate the presence of AP in our study. Previous studies have also used OPG (***Imfeld 1991***[49]***, Kirkevang et al.2001***[50]***, Boucher et al. 2002***[51]***, Britto et al. 2003***[18]***, Kirkevang & Wenzel 2003***[52]). Moreover, the Periapical Index score (PAI) used for scoring periapical status was first described for periapical radiographs (***Ørstavik et al. 1986***[19]) and has been widely used in the literature (***Eriksen et al. 1995***[53]***, Marques et al. 1998***[54]***, Sidaravicius et al. 1999***[55]***, Kirkevang et al. 2001, Boucher et al. 2002, Kirkevang & Wenzel 2003, Segura-Egea et al. 2004***[22]). In our study, all teeth, excluding third molars, were recorded. Patients with total number of teeth less than 14 were excluded. Grossly decayed teeth were considered as absent. Thus, the results reproduced the periapical status of the subjects. Other authors, in similar studies, have excluded teeth with absent or defective coronal restorations, teeth with their periradicular tissues near radiolucent anatomic structures, or root filled teeth with inadequate root canal treatment ***(Britto et al. 2003***[18]***).*** However, these exclusions may alter the results and prevent the determination of the real periapical status of the subjects.

The average number of teeth was similar in diabetic patients (25.6±2.4) and non diabetic controls (25.3±2.4). This is in contrast to what was observed by ***Lopez et al***[12] in a study done in Spain in 2011. The author observed that the average number of teeth was significantly lower in diabetic patients (21.9 ± 6.4 and) than in control subjects (24.6 ± 3.8). It was proposed that Diabetes Mellitus, especially when poorly controlled, was associated with significant tooth loss because of the increased incidence and severity of caries and the aggressive forms of periodontal disease associated with diabetes. However, in another study done by ***Falk et al. (1989[56])***, there was no significant difference in the number of teeth between diabetic and non diabetic subjects. One possible explanation for this could be that we had excluded grossly decayed teeth and patients with less than 14 teeth. Thus the influence of periodontal disease has been minimized in our study.

Endodontology includes pulp and periapical biology and pathology. Whilst the initial diagnoses and the difficulties associated with treatment may be related to the state of the pulp, the ultimate biological aim of this treatment is no longer the preservation of the pulp, but the prevention and elimination of infection in the root canal system to prevent or cure apical periodontitis (AP)[32]. Apical periodontitis, an inflammatory process around the apex of a root, is primarily a sequel to microbial infection of the pulp space. The infectious etiology of AP and the main role of microbial factors in the initiation, development and persistence of the condition have been widely documented, and it can be considered as a disease of bacterial infection.

Apical periodontitis is a remarkably prevalent condition, especially in a country like India[25, 57]. The prevalence of AP is as high as 61% of individuals and 2.8–4.2% of the teeth, as noted by Segura et al, 2015[32]. Inadequate aseptic control, poor access cavity design, missed canals, insufficient instrumentation and leaking temporary or permanent restorations are common problems that may lead to persistent AP.

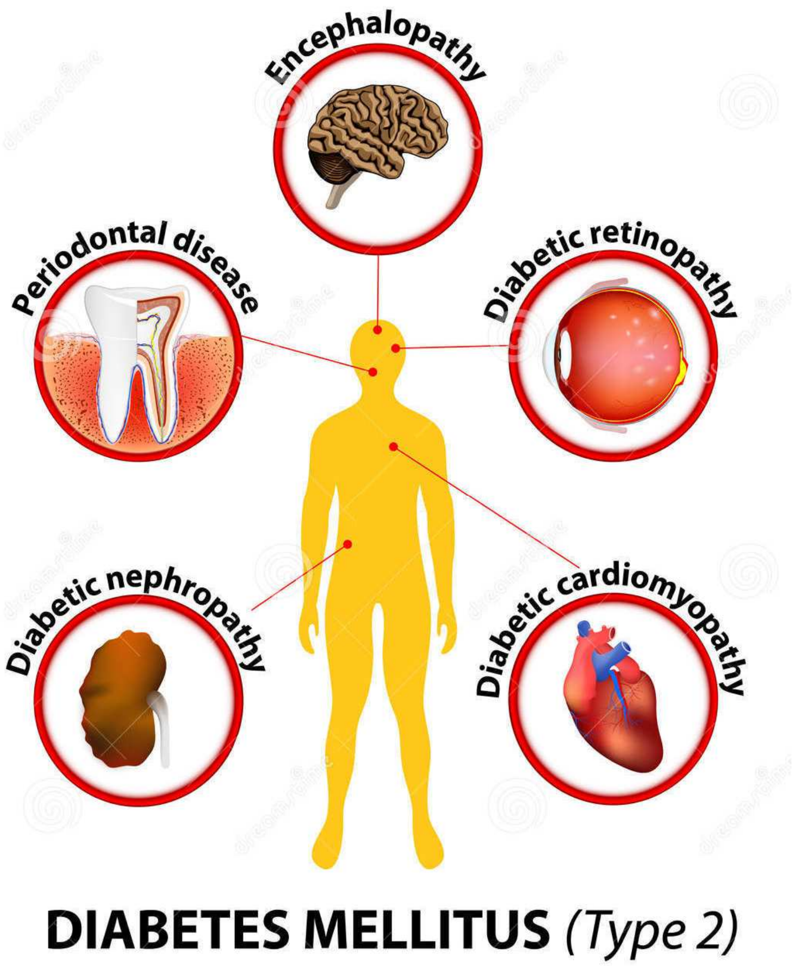
Even though periapical infections cause a number of local tissue responses with the purpose of limiting the spread of the infectious elements, AP may not exclusively be a local phenomenon. The interaction between the lipopolysaccharide (LPS) from anaerobic gram-negative bacteria causing AP with Toll-like receptor 4 (TLR4) on macrophages and neutrophils activates the broad axis of innate immunity, up-regulating pro-inflammatory cytokines such as IL-1b, IL-6, IL-8, TNF-a and prostaglandin E2 (PGE2). These cytokines may be released into the systemic circulation inducing or perpetuating an elevated chronic systemic inflammatory status. Although there is no conclusive scientific evidence indicating that an infected root canal may act as a focus of infection to distant body sites (except for systemically compromised patients), the opposite has not been proven either, that is, there is no clear evidence showing that endodontic infections are an isolated event with no effect on the rest of the body.

In the two last decades, '*periodontal medicine*' has developed as a distinct area that focuses on the relationship between periodontal disease (PD) and systemic diseases[58]. Several epidemiological studies have found associations between systemic health and PD. Thus, PD has been associated with diabetes mellitus (DM), coronary heart disease (CHD) and acute myocardial infarction (AMI), preterm-low birthweight, respiratory diseases, osteoporosis in post-menopause women, metabolic syndrome and early loss of memory and capacity for calculation. The evidence of the association between PD and systemic diseases has focused attention on the diagnosis and treatment of PD, improving, consequently, the patient's oral and systemic health. **(Figure 18)**

Chronic periodontal and endodontic inflammatory processes have three important similarities:

1. Both are chronic infections of the oral cavity
2. Both are polymicrobial infections sharing a common microbiota with a predominance of Gram-negative anaerobic bacteria.
3. Elevated cytokine levels may be released systemically from acute and chronic manifestations of both disease processes, for example increased concentrations of inflammatory mediators have been detected both in the gingival crevicular fluid of subjects with PD and in the periapical tissues of endodontically involved teeth.

Figure 18 – Macrovascular & Microvascular Complications of Type 2 Diabetes Mellitus



Likewise, one might assume that AP is associated with the same systemic disorders that are associated with PD. Therefore, 'endodontic medicine' should be developed following the same path as 'periodontal medicine': evaluating the association between endodontic and systemic diseases. However, the influence that chronic periapical processes could produce on highly prevalent systemic diseases, such as diabetes and congenital heart disease has been poorly studied. The lack of scientific studies on this topic might be masking the potential risk of retaining teeth with chronic AP and the real importance and health advantages of endodontic treatments to patients, doctors and dentists. Pro-inflammatory status and impaired immune response associated with systemic diseases can affect the reparative response of the dental pulp and periapical healing, influencing the two main endodontic variables: the prevalence of AP and the frequency of RCT.

Diabetes mellitus is a clinically and genetically heterogeneous group of disorders affecting the metabolism of carbohydrates, lipids and proteins, in which hyperglycaemia is a main feature *(Expert Committee on the Diagnosis and Classification of Diabetes Mellitus 2000[59])*. These disorders are due to a deficiency in insulin secretion caused by pancreatic b-cell dysfunction and/or insulin resistance in liver and muscle. Diabetes affects more than 9% of the adult population, and its high morbidity and mortality amongst affected individuals has a substantial impact on national healthcare systems. Age-adjusted and country-adjusted prevalence of Type 2 diabetes mellitus (T2DM) in 11 European countries in 2004 was 10.2% in men and 8.5% in women ***(Espelt et al. 2013[60])***. India leads the world with largest number of diabetic subjects earning the term "DIABETES CAPITAL OF THE WORLD."

According to Indian council of medical research data published in 2006[1], prevalence of type 2 diabetes in India is 40.9 million and is expected to rise to 69.9 million by 2025.

Glycated haemoglobin (HbA1c) has been used as a 'gold standard' for mean glycaemia and as a measure of risk for the development of DM complications ***(Expert Committee on the Diagnosis and Classification of Diabetes Mellitus 2000)***[58]. The American Association of Clinical Endocrinologists (AACE)[61] considers HbA1c levels ≤6.5% as a goal for optimal glycaemic control in diabetic patients. Type 1 diabetes results from cellular-mediated autoimmune destruction of pancreatic b-cells, which usually leads to total loss of insulin secretion; in contrast, type 2 diabetes is caused by resistance to insulin combined with a failure to produce enough additional insulin to compensate for the resistance. Many studies have shown that inflammation plays a very important role in the pathogenesis of T2DM.

In animal studies, histological and histometrical changes in pulpal and periapical tissues after pulpal exposure in streptozotocin-induced diabetic rats have been studied[24, 38]. It was observed that more pronounced periapical inflammation and larger periapical lesions were seen in diabetic rats compared with controls. The effect of hyperglycaemia on pulp healing in exposed rat pulps capped with Mineral Trioxide Aggregate (MTA) has also been investigated. There was an inverse association between dentine bridge formation and inflammatory cell infiltration: dentine bridge formation was inhibited in diabetic rats and more inflammation was observed in these pulps. It has also been shown that oral infections affect glycaemic conditions in diabetic rats and increase HbA1c levels in normoglycaemic and diabetic rats.

Several clinical and epidemiological studies carried out in humans have analysed the association between endodontic variables and DM[11, 12]. The main endodontic variables analysed in these studies are as follows:

1. The prevalence of AP
2. The prevalence of RCT and
3. The outcome of RCT, assessed as the percentage of RFT with or without PLs, or as the prevalence of tooth extraction after nonsurgical RCT (NSRCT).

The results of studies conducted so far are inconclusive, but suggest an association between DM and a higher prevalence of AP.

In the present study, diabetic patients showed a higher prevalence of AP (88%) compared with age- and sex-matched control subjects (75%; $p < 0.05$). This is in accordance with previous reports by ***Segura et al.2005***[13]***, Bender et al 2003***[37]***, Lopez et al 2011***[12]. On the contrary, ***Britto et al (2003)***[18] in a similar study design, investigated the prevalence of radiographic periradicular radiolucencies in root-filled teeth and untreated teeth in patients with and without diabetes and found no significant differences in the prevalence of AP between diabetics and controls. However, these investigators excluded teeth with absent or defective coronal restorations, teeth with their periradicular tissues near radiolucent anatomic structures, and root-filled teeth with inadequate root canal treatment. Because of this, their results do not reflect the real periapical status of the subjects studied, and the comparison between both groups cannot produce definite conclusions. The number of diabetics and control subjects in our study (40 and 80 respectively) were more than the number of subjects included in the previous studies. All the studies that have been quoted above, have been done in the Western world. Our study is one of the first in the Indian population.

On comparing the number of patients having one tooth with AP and those having more than one teeth with AP, in the present study it was observed that 34 out of 40 diabetics had more than one teeth with AP, whereas 32 out of 80 non diabetics had only 1 tooth with AP. This difference was statistically highly significant with a p value of < 0.001. ***Marotta Patricia et al (2012*[11]***)*** found no significant differences when the analysis involved either the number of patients with at least 1 AP lesion or the mean number of lesions per individual. But the sample size in their study was too small (30 diabetics and 30 non diabetics). Our study observed results similar to ***Lopez et al (2011)***[12] ***and Segura et al (2005)***[13].

The prevalence of root canal treatment was similar in both the groups, and there were no significant differences between the percentages of diabetic and nondiabetic individuals. It is worth pointing out that this factor involves other variables, such as the accessibility of patients to dental care. As reported earlier, we tried to avoid this bias by including only individuals belonging to a similar socioeconomic status and attending our dental college for the first time.

The prevalence of AP in root canal–treated teeth may be suggestive of the success rate of the treatment although data should be viewed with care because of the cross-sectional nature of the study. In our study, 41% of diabetic root canal treated teeth, had AP compared to only 29% of non diabetic root canal treated teeth with AP ($p < 0.05$). ***Foud et al (2003)***[21] concluded that patients with diabetes displayed a reduced success rate in endodontic treatments of teeth with preoperative AP. ***Britto et al (2003)***[18] also observed similar findings. It has been hypothesized that diabetes may increase the rate of endodontic failure and persistent AP, and this statement is supported by the results of the present study. There is scientific evidence to demonstrate a poorer prognosis for root filled teeth (RFT) in diabetics. Thus, diabetic patients have delayed periapical repair and greater likelihood of RFT loss.

Metabolic control of diabetes mellitus and apical periodontitis

The lack of control in DM could delay healing of PLs and increase their size, despite having received endodontic treatment. In well-controlled diabetic patients PLs healed as readily as in nondiabetics. In our study, we determined the metabolic control of DM by measuring glycated haemoglobin levels and classifying diabetic patients as well-controlled (HbA1c < 6.5%) or poor-controlled (HbA1c > 6.5%). 80% of diabetics with poor glycemic control had apical periodontitis whereas only 20 % of diabetics with good glycemic control had AP ($p < 0.001$).

It is also interesting to note that chronic periapical disease may contribute to diabetic metabolic dyscontrol. There are a few studies which have shown better glycemic control after treatment of the periapical disease. ***Bender et al (2003)***[37] reported that removal of the periapical inflammatory state usually creates a need for a lesser amount of insulin for diabetic control. Thus, achieving a good glycemic control decreases the chance of chronic apical periodontitis, and adequate treatment of AP helps is achieving adequate glycemic control.

Figure 19 - Biological mechanisms linking periapical status and diabetes mellitus

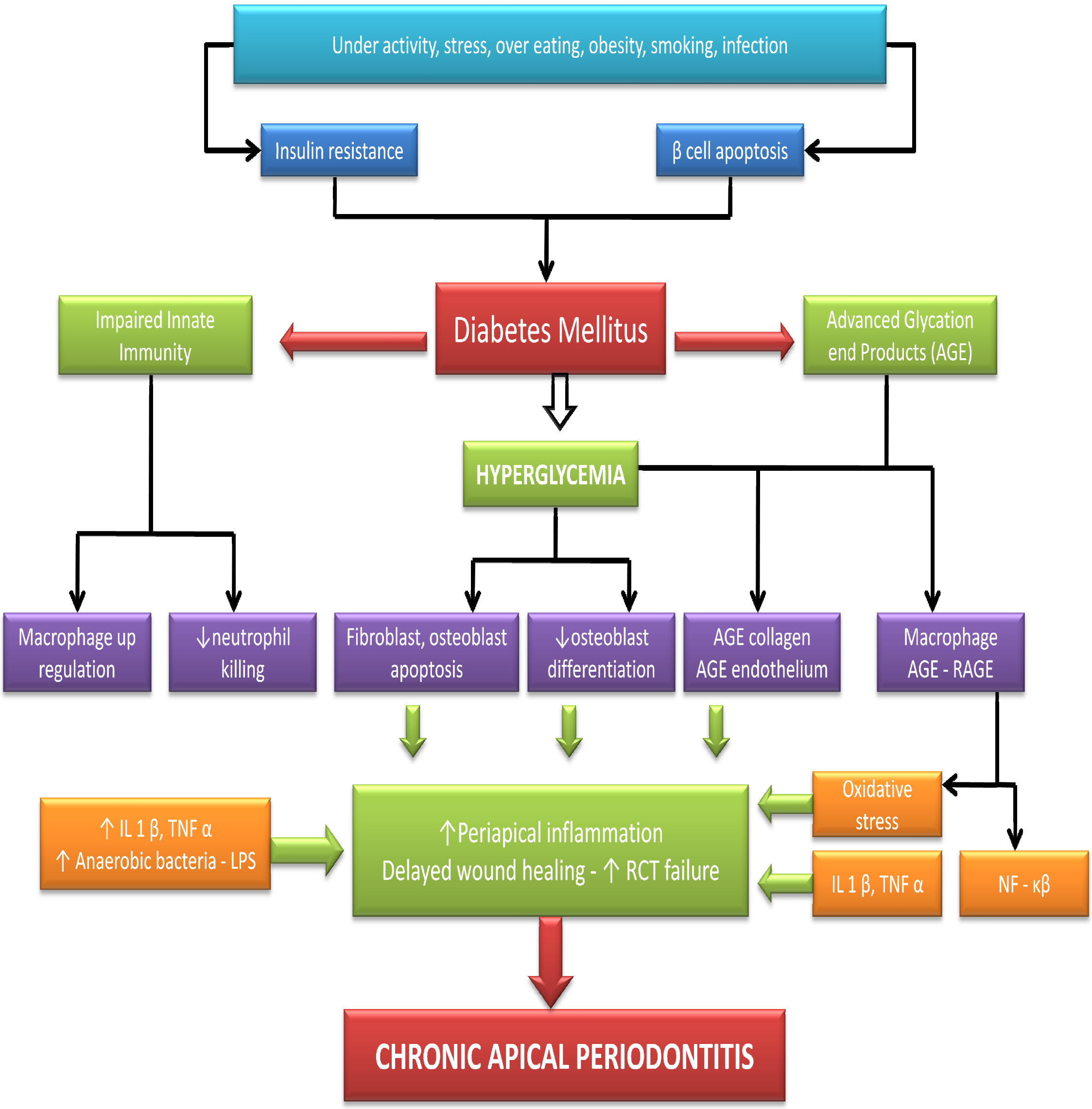
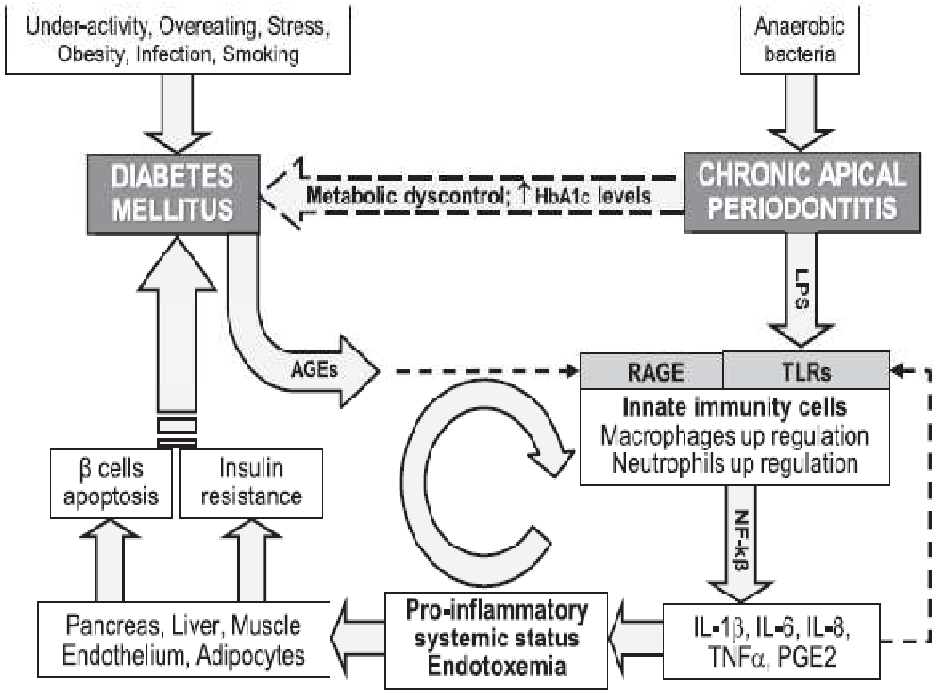


Figure 20 - Mechanisms by which periapical status could affect glycemic control



1. Being a cross sectional study, one of the major limitation is the fact that the mean time since completion of endodontic treatment is unknown.

2. The number of teeth assessed for adequacy of endodontic treatment was too small.

SUMMARY AND CONCLUSION

The aim of this cross-sectional study was to compare the prevalence of apical periodontitis and endodontic treatment between patients with type 2 diabetes and those without diabetes. 40 diabetics and 80 non diabetics (age and sex matched), with ages ranging from 40 to 65 years, who were attending the oral medicine department for routine dental care, were included in the study. All the subjects in both the groups, underwent a digital panoramic radiograph of the jaws to evaluate the periapical and endodontic status. Grossly decayed teeth were considered as absent, patients with total number of teeth less than 14 were excluded and the third molars were also excluded. Periapical index (PAI) score was used to assess the periapical status. A score greater than 2 (PAI ≥ 3) was considered to be a sign of periapical pathology. Four observers who were blinded, assessed the radiographs independently and the ***true mean score*** was calculated. The prevalence of apical periodontitis in root canal treated and untreated teeth, between both the groups were compared and tabulated. Glycated hemoglobin (HbA1c) levels were measured in diabetics to assess their glycemic control. An attempt was made to find out if the level of glycemic control had any effect on the prevalence of apical periodontitis. Random blood sugar (RBS) levels were measured for the non diabetic group, to pick up undiagnosed type 2 diabetes mellitus.

Data were statistically analyzed to evaluate the significance in the differences between both the groups. Wilcoxon signed rank test and Mc Nemar tests were used when the individual was the unit of analysis, whereas the chi – square test with Yates correction was used when the tooth was the unit of analysis.

The results showed a higher prevalence of apical periodontitis in patients with type 2 diabetes mellitus. However, considering the limitations of cross-sectional studies, larger prospective clinical studies are further needed to confirm this association. As diabetes is one of the most prevalent conditions in medically compromised patients seeking dental treatment, dentists should be aware of the possible relationship between endodontic infections and diabetes mellitus. It is very vital for dental clinicians to understand the disease process of type 2 diabetes, its effect on pulp and periapical diseases, and treatment outcome to provide competent endodontic treatment to patients with type 2 diabetes mellitus.

Within the limitations of the study, it can be concluded that apical periodontitis was significantly more prevalent in teeth from type 2 diabetic individuals. This higher prevalence was observed in root canal treated and untreated teeth, with decreased success rate of endodontic treatment. These findings suggest that diabetes can serve as a disease modifier of apical periodontitis, which implies that individuals with diabetes may be more prone to develop primary apical periodontitis. Even in diabetics, those with good glycemic control, are likely to have a lesser risk of acquiring apical periodontitis.

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